



## Natural Resources Conservation Service

### CONSERVATION PRACTICE STANDARD

### NUTRIENT MANAGEMENT

#### CODE 590

#### (ac)

#### DEFINITION

Managing the amount (rate), source, placement (method of application), and timing of plant nutrients and soil amendments.

#### PURPOSE

This practice is used to accomplish one or more of the following purposes:

- To budget, supply, and conserve nutrients for plant production
- To minimize agricultural nonpoint source pollution of surface and groundwater resources
- To properly utilize manure or organic by-products as a plant nutrient source
- To protect air quality by reducing odors, nitrogen emissions (ammonia, oxides of nitrogen), and the formation of atmospheric particulates
- To maintain or improve the physical, chemical, and biological condition of soil

#### CONDITIONS WHERE PRACTICE APPLIES

This practice applies to all lands where plant nutrients and soil amendments are applied. This standard does not apply to one-time nutrient applications to establish perennial crops.

#### CRITERIA

##### General Criteria Applicable to All Purposes

A nutrient budget for nitrogen, phosphorus, and potassium must be developed that considers all sources of nutrients including, but not limited to, green manures, legumes, crop residues, compost, animal manure, organic by-products, biosolids, waste water, organic matter, soil biological activity, commercial fertilizer, and irrigation water.

Enhanced efficiency fertilizers, used in the State must be defined as such by the Association of American Plant Food Control Officials (AAPFCO) and be accepted for use by the State fertilizer control official, or similar authority, with responsibility for verification of product guarantees, ingredients (by AAPFCO definition) and label claims.

For nutrient risk assessment policy and procedures see Title 190, General Manual (GM), Part 402, Nutrient Management, and Title 190, National Instruction (NI), Part 302, Nutrient Management Policy Implementation.

To avoid salt damage, the rate and placement of applied nitrogen and potassium in starter fertilizer must be consistent with University of Tennessee guidelines.

The NRCS-approved nutrient risk assessment for **nitrogen** must be completed on all sites.

The NRCS-approved nutrient risk assessment for **phosphorus** must be completed when:

- phosphorus application rate exceeds University of Tennessee fertility rate guidelines for the planned crop(s), or
- the planned area is adjacent to a water body that has been identified by Tennessee Department of Environment and Conservation (TDEC) as being impaired (i.e. 303d-listed) for nutrients.

TN NRCS, with concurrence of TDEC, has determined specific conditions where the risk of phosphorus loss is low. A phosphorus risk assessment will not be required on an individual field when all 4 of the following conditions are met:

- Low or medium soil test phosphorus (STP) levels based on current soil test(s)
- Slope is less than or equal to 5%
- Soil loss is less than or equal to the soil loss tolerance (T)
- Nutrient application(s) will not exceed University of Tennessee recommendations.

When a field(s) has met all low risk conditions for phosphorus, the producer(s) is still required to meet all other field-specific TN NRCS conservation objectives and standards, including manure application setbacks and proper timing of manure applications.

On organic operations, the nutrient sources and management must be consistent with the USDA's National Organic Program.

Areas contained within minimum application setbacks (e.g., sinkholes, wellheads, gullies, ditches, or surface inlets) must receive nutrients consistent with the setback restrictions. Refer to Table 1 on page 9 of this standard.

Applications of irrigation water must minimize the risk of nutrient loss to surface and groundwater.

Soil pH must be maintained in a range that enhances an adequate level for crop nutrient availability and utilization. Refer to University of Tennessee documentation for guidance at:

<https://ag.tennessee.edu/spp/Pages/soilfertilizerpubs.aspx> .

### **Soil, Manure, and Tissue Sampling and Laboratory Analyses (Testing)**

Nutrient planning must be based on current soil, manure, and (where used as supplemental information) plant tissue test results developed in accordance with University of Tennessee guidance. For additional information, refer to: <https://ag.tennessee.edu/spp/Pages/default.aspx>

Current soil tests are those that are no older than 2 years, but may be taken on an interval recommended by the University of Tennessee or as required by State code. The area represented by a soil test must be 10 acres or less as recommended by the University of Tennessee. Refer to University of Tennessee publication PB1061 for further information at:

<https://utextension.tennessee.edu/publications/Documents/PB1061.pdf>

When developing new plans, soil test information will be no older than 1 year.

Where a conservation management unit (CMU) is used as the basis for a sampling unit, all acreage in the CMU must have similar soil type, cropping history, and management practice treatment. The soil testing area within the CMU must be 10 acres or less as recommended by the University of Tennessee.

The soil and plant tissue tests must include analyses pertinent to monitoring or amending the annual nutrient budget, e.g., pH, electrical conductivity (EC) and sodicity where salts are a concern, soil organic matter, phosphorus, potassium, or other nutrients and test for nitrogen where applicable. Follow University of Tennessee guidelines regarding required analyses at: <https://ag.tennessee.edu/spp/Pages/default.aspx>

Soil test analyses must be performed by laboratories successfully meeting the requirements and performance standards of the North American Proficiency Testing Program- Performance Assessment Program (NAPT-PAP) under the auspices of the Soil Science Society of America (SSSA) and NRCS, or other NRCS- approved program that considers laboratory performance and proficiency to assure accuracy of soil test results and utilize the Mehlich 1 or Mehlich 3 extractant for nutrients. Alternate proficiency testing programs must have solid stakeholder (e.g., water quality control entity, NRCS State staff, growers, and others) support and be regional in scope.

Nutrient values of manure, organic by-products and biosolids must be determined prior to land application.

Manure analyses must include, at minimum, total nitrogen (N), ammonium N, total phosphorus (P) or  $P_2O_5$ , total potassium (K) or  $K_2O$ , and percent solids, or follow University of Tennessee guidance regarding required analyses.

Manure, organic by-products, and biosolids samples must be collected and analyzed at least annually, or more frequently if needed to account for operational changes (feed management, animal type, manure handling strategy, etc.) impacting manure nutrient concentrations.

Samples must be collected, prepared, stored, and shipped, following University of Tennessee guidelines. For additional information refer to Procedures for Manure and Litter Sampling at: <https://utextension.tennessee.edu/publications/Documents/W093.pdf>

When planning for new or modified livestock operations, acceptable “book values” recognized by the NRCS (e.g., NRCS Agricultural Waste Management Field Handbook) and the University of Tennessee, or analyses from similar operations in the geographical area, may be used if they accurately estimate nutrient output from the proposed operation.

Manure testing analyses must be performed by laboratories successfully meeting the requirements and performance standards of the Manure Testing Laboratory Certification program (MTLCP) under the auspices of the Minnesota Department of Agriculture, or other NRCS- approved program that considers laboratory performance and proficiency to assure accurate manure test results. For additional information, refer to: <http://www2.mda.state.mn.us/webapp/lis/manurelabs.jsp>

### **Nutrient Application Rates**

Planned nutrient application rates for nitrogen, phosphorus, and potassium must not exceed University of Tennessee guidelines or industry practice when recognized by the university.

At a minimum, determination of rate must be based on crop/cropping sequence, current soil test results, realistic yield goals, and NRCS- approved nutrient risk assessments.

If the University of Tennessee does not provide specific guidance that meets these criteria, application rates must be based on plans that consider realistic yield goals and associated plant nutrient uptake rates.

Realistic yield goals must be established based on historical yield data (minimum of 5 years), soil productivity information, climatic conditions, nutrient test results, level of management, and local research results considering comparable production conditions.

Estimates of yield response must consider factors such as poor soil quality, drainage, pH, salinity, etc., prior to assuming that nitrogen and/or phosphorus are deficient.

For new crops or varieties, industry- demonstrated yield, and nutrient utilization information may be used until University of Tennessee information is available.

Lower-than-recommended nutrient application rates are permissible if the grower's objectives are met.

Applications of biosolids, starter fertilizers, or pop-up fertilizers must be accounted for in the nutrient budget.

### **Nutrient Sources**

Nutrient sources utilized must be compatible with the application timing, tillage and planting system, soil properties, crop, crop rotation, soil organic content, and local climate to minimize risk to the environment.

### **Nutrient Application Timing and Placement**

Timing and placement of all nutrients must correspond as closely as practical with plant nutrient uptake (utilization by crops), and consider nutrient source, cropping system limitations, soil properties, weather conditions, drainage system, soil biology, and nutrient risk assessment results.

Nutrients must not be surface-applied if nutrient losses offsite are likely. This precludes spreading on:

- frozen and/or snow-covered soils, and
- when the top 2 inches of soil are saturated from rainfall or snow melt.

### **Additional Criteria to Minimize Agricultural Nonpoint Source Pollution of Surface and Groundwater**

Planners must use the current NRCS-approved nitrogen, phosphorus, and soil erosion risk assessment tools to assess the risk of nutrient and soil loss. Identified resource concerns must be addressed to meet current planning criteria (quality criteria). Technical criteria for risk assessments can be found in NI-190-302.

When there is a high risk of transport of nutrients, conservation practices must be coordinated to avoid, control, or trap manure and nutrients before they can leave the field by surface or subsurface drainage (e.g., tile). The number of applications and the application rates must also be considered to limit the transport of nutrients to tile.

Nutrients must be applied with the right placement, in the right amount, at the right time, and from the right source to minimize nutrient losses to surface and groundwater. The following nutrient use efficiency strategies or technologies must be considered:

- slow and controlled release fertilizers
- nitrification and urease inhibitors
- enhanced efficiency fertilizers
- incorporation or injection
- timing and number of applications
- soil nitrate and organic N testing
- coordinate nutrient applications with optimum crop nutrient uptake
- Corn Stalk Nitrate Test (CSNT), Pre- Sidedress Nitrate Test (PSNT), and Pre- Plant Soil Nitrate Test (PPSN)
- plant tissue testing, chlorophyll meters, and spectral analysis technologies
- other University of Tennessee recommended technologies that improve nutrient use efficiency and minimize surface or groundwater resource concerns.

### **Additional Criteria Applicable to Properly Utilize Manure or Organic By-Products as a Plant Nutrient Source**

When manures are applied, and soil salinity is a concern, salt concentrations must be monitored to prevent potential crop damage and/or reduced soil quality.

The total single application of liquid manure:

- must not exceed the soil's infiltration or water holding capacity
- be based on crop rooting depth
- must be adjusted to avoid runoff or loss to subsurface tile drains.

Crop production activities and nutrient use efficiency technologies must be coordinated to take advantage of mineralized plant-available nitrogen to minimize the potential for nitrogen losses due to denitrification or ammonia volatilization.

Nitrogen and phosphorus application rates must be planned based on risk assessment results as determined by NRCS-approved nitrogen and phosphorus risk assessment tools.

For fields receiving manure, where phosphorus risk assessment results equate to LOW risk, additional phosphorus and potassium can be applied at rates greater than crop requirement not to exceed the nitrogen requirement for the succeeding crop. For fields receiving manure, where phosphorus risk assessment results equate to MODERATE risk, additional phosphorus and potassium may be applied at a phosphorus crop requirement rate for the planned crops in the rotation. When phosphorus risk assessment results equate to HIGH risk, additional phosphorus and potassium may be applied at phosphorus crop removal rates if the following requirements are met:

- a soil phosphorus drawdown strategy has been implemented, and
- a site assessment for nutrients and soil loss has been conducted to determine if mitigation practices are required to protect water quality.
- any deviation from these high risk requirements must have the approval of the Chief of the NRCS.

Manure or organic by-products may be applied on legumes at rates equal to the estimated removal of nitrogen in harvested plant biomass, not to exceed University of Tennessee crop removal recommendations.

Manure may be applied at a rate equal to the recommended phosphorus application, or estimated phosphorus removal in harvested plant biomass for the crop rotation, or multiple years in the crop sequence at one time. When such applications are made, the application rate must not exceed the acceptable phosphorus risk assessment criteria, must not exceed the recommended nitrogen application rate during the year of application or harvest cycle, and no additional phosphorus must be applied in the current year and any additional years for which the single application of phosphorus is supplying nutrients.

#### **Additional Criteria to Protect Air Quality by Reducing Odors, Nitrogen Emissions and the Formation of Atmospheric Particulates**

To address air quality concerns caused by odor, nitrogen, sulfur, and/or particulate emissions; the source, timing, amount, and placement of nutrients must be adjusted to minimize the negative impact of these emissions on the environment and human health. One or more of the following may be used:

- slow or controlled release fertilizers
- nitrification inhibitors
- urease inhibitors
- nutrient enhancement technologies
- incorporation
- injection
- stabilized nitrogen fertilizers
- residue and tillage management
- no-till or strip-till
- other technologies that minimize the impact of these emissions

Do not apply poultry litter, manure, or organic by-products of similar dryness/density when there is a high probability that wind will blow the material offsite.

**Additional Criteria to Improve or Maintain the Physical, Chemical, and Biological Condition of the Soil to Enhance Soil Quality for Crop Production and Environmental Protection**

Time the application of nutrients to avoid periods when field activities will result in soil compaction.

**CONSIDERATIONS**

Soil test phosphorus levels should not exceed State-approved soil test thresholds established to protect the environment.

Use no-till/strip-till in combination with cover crops to sequester nutrients, increase soil organic matter, increase aggregate stability, reduce compaction, improve infiltration, and enhance soil biological activity to improve nutrient use efficiency.

Use nutrient management strategies such as cover crops, crop rotations, and crop rotations with perennials to improve nutrient cycling and reduce energy inputs.

Use variable-rate nitrogen application based on expected crop yields, soil variability, soil nitrate or organic N supply levels, or chlorophyll concentration.

Use variable-rate nitrogen, phosphorus, and potassium application rates based on site- specific variability in crop yield, soil characteristics, soil test values, and other soil productivity factors.

Develop site-specific yield maps using a yield monitoring system. Use the data to further diagnose low- and high- yield areas, or zones, and make the necessary management changes. See Title 190, Agronomy Technical Note (TN) 190.AGR.3, Precision Nutrient Management Planning.

Use manure management conservation practices to manage manure nutrients to limit losses prior to nutrient utilization.

Apply manure at a rate and method that will result in an “improving” Soil Conditioning Index (SCI) without exceeding acceptable risk of nitrogen or phosphorus loss.

Use legume crops and cover crops to provide nitrogen through biological fixation and nutrient recycling.

Modify animal feed diets to reduce the nutrient content of manure following guidance contained in Conservation Practice Standard (CPS) Code 592, Feed Management.

Excessive levels of some nutrients can cause induced deficiencies of other nutrients, e.g., high soil test phosphorus levels can result in zinc deficiency in corn.

Use soil tests, plant tissue analyses, and field observations to check for secondary plant nutrient deficiencies or toxicities that may impact plant growth or availability of the primary nutrients.

Use the adaptive nutrient management learning process to improve nutrient use efficiency on farms as outlined in the NRCS' National Nutrient Policy in GM 190, Part 402, Nutrient Management.

Potassium should not be applied in situations where an excess (greater than soil test potassium recommendation) causes nutrient imbalances in crops or forages.

Workers should be protected from and avoid unnecessary contact with plant nutrient sources.

Extra caution must be taken when handling anhydrous ammonia or when dealing with organic wastes stored in unventilated enclosures.

Material generated from cleaning nutrient application equipment should be utilized in an environmentally safe manner. Excess material should be collected and stored or field applied in an appropriate manner.

Nutrient containers should be recycled in compliance with State and local guidelines or regulations.



### **Considerations to Minimize Agricultural Nonpoint Source Pollution of Surface and Groundwater**

Use conservation practices that slow runoff, reduce erosion, and increase infiltration, e.g., filter strip, contour farming, or contour buffer strips. These practices can also reduce the loss of nitrates or soluble phosphorus.

Use application methods and timing strategies that reduce the risk of nutrient transport by ground and surface waters, such as:

- split applications of nitrogen to deliver nutrients during periods of maximum crop utilization,
- banded applications of nitrogen and/or phosphorus to improve nutrient availability,
- drainage water management to reduce nutrient discharge through drainage systems, and
- incorporation of surface-applied manures or organic by-products if precipitation capable of producing runoff or erosion is forecast within the time of planned application.

Use the agricultural chemical storage facility conservation practice to protect air, soil, and water quality.

### **Considerations to Protect Air Quality by Reducing Nitrogen and/or Particulate Emissions to the Atmosphere**

Avoid applying manure and other by-products upwind of inhabited areas.

Use high-efficiency irrigation technologies (e.g., reduced-pressure drop nozzles for center pivots) to reduce the potential for nutrient losses.

Consider utilizing windbreaks and/or shelterbelts to improve air quality by reducing and intercepting air borne particulate matter, chemicals and odors.

## **PLANS AND SPECIFICATIONS**

The following components must be included in the nutrient management plan:

- aerial site photograph(s)/imagery or site map(s), and a soil survey map of the site,
- soil information including: soil type surface texture, pH, drainage class, permeability, available water capacity, depth to water table, restrictive features, and flooding and/or ponding frequency,
- location of designated sensitive areas and the associated nutrient application restrictions and setbacks,
- for manure applications, location of nearby residences, or other locations where humans may be present on a regular basis, and any identified meteorological (e.g., prevailing winds at different times of the year), or topographical influences that may affect the transport of odors to those locations,
- results of approved risk assessment tools for nitrogen, phosphorus, and erosion losses,
- documentation establishing that the application site presents low risk for phosphorus transport to local water when phosphorus is applied in excess of crop requirement.
- current and/or planned plant production sequence or crop rotation,
- soil, water, compost, manure, organic by- product, and plant tissue sample analyses applicable to the plan,
- when soil phosphorus levels are increasing, include a discussion of the risk associated with phosphorus accumulation and a proposed phosphorus draw-down strategy,
- realistic yield goals for the crops,
- complete nutrient budget for nitrogen, phosphorus, and potassium for the plant production sequence or crop rotation,
- listing and quantification of all nutrient sources and form,
- all enhanced efficiency fertilizer products that are planned for use,

- in accordance with the nitrogen and phosphorus risk assessment tool(s), specify the recommended nutrient application source, timing, amount (except for precision/variable rate applications specify method used to determine rate), and placement of plant nutrients for each field or management unit, and
- guidance for implementation, operation and maintenance, and recordkeeping.

In addition, the following components must be included in a precision/variable rate nutrient management plan:

- Document the geo-referenced field boundary and data collected that was processed and analyzed as a GIS layer or layers to generate nutrient or soil amendment recommendations.
- Document the nutrient recommendation guidance and recommendation equations used to convert the GIS base data layer or layers to a nutrient source material recommendation GIS layer or layers.
- Document if a variable rate nutrient or soil amendment application was made.
- Provide application records per management zone or as applied map within individual field boundaries (or electronic records) documenting source, timing, method, and rate of all applications that resulted from use of the precision agriculture process for nutrient or soil amendment applications.
- Maintain the electronic records of the GIS data layers and nutrient applications for at least 5 years

If increases in soil phosphorus levels are expected (i.e., when N-based rates are used), the nutrient management plan must document:

- the soil phosphorus levels at which it is desirable to convert to phosphorus based planning,
- the potential plan for soil test phosphorus drawdown from the production and harvesting of crops, and
- management activities or techniques used to reduce the potential for phosphorus transport and loss,
- for AFOs, a quantification of manure produced in excess of crop nutrient requirements, and
- a long-term strategy and proposed implementation timeline for reducing soil P to levels that protect water quality,

## **OPERATION AND MAINTENANCE**

Conduct periodic plan reviews to determine if adjustments or modifications to the plan are needed. At a minimum, plans must be reviewed and revised, as needed with each soil test cycle, changes in manure volume or analysis, crops, or crop management.

Fields receiving animal manures and/or biosolids must be monitored for the accumulation of heavy metals and phosphorus in accordance with the University of Tennessee and State law.

Significant changes in animal numbers, management, and feed management will necessitate additional manure analyses to establish a revised average nutrient content.

Calibrate application equipment to ensure accurate distribution of material at planned rates.

Document the nutrient application rate. When the applied rate differs from the planned rate, provide appropriate documentation for the change.

Records must be maintained for at least 5 years to document plan implementation and maintenance. As applicable, records include:

- soil, plant tissue, water, manure, and organic by-product analyses resulting in recommendations for nutrient application,



- quantities, analyses and sources of nutrients applied,
- dates, and method(s) of nutrient applications, source of nutrients, and rates of application,
- weather conditions and soil moisture at the time of application; lapsed time to manure incorporation; rainfall or irrigation event,
- crops planted, planting and harvest dates, yields, nutrient analyses of harvested biomass, and crop residues removed,
- dates of plan review, name of reviewer, and recommended changes resulting from the review, and
- all enhanced efficiency fertilizer products used.

Additional records for precision/variable rate sites must include:

- maps identifying the variable application source, timing, amount, and placement of all plant nutrients applied, and
- GPS-based yield maps for crops where yields can be digitally collected.

## REFERENCES

Association of American Plant Food Control Officials (AAPFCO). 2011. AAPFCO Official Publication no. 64. AAPFCO Inc., Little Rock, AR.

Follett, R.F. 2001. Nitrogen transformation and transport processes. *In* Nitrogen in the environment; sources, problems, and solutions, (eds.) R.F. Follett and J. Hatfield, pp. 17-44. Elsevier Science Publishers. The Netherlands. 520 pp.

Schepers, J.S., and W.R. Ruan, (eds.) 2008. Nitrogen in agricultural systems. Agron. Monogr. no. 49, American Society of Agronomy (ASA), Crop Science Society of America (CSSA), Soil Science Society of America (SSSA). Madison, WI.

Sims, J.T. (ed.) 2005. Phosphorus: Agriculture and the environment. Agron. Monogr. no. 46. ASA, CSSA, and SSSA, Madison, WI.

Stevenson, F.J. (ed.) 1982. Nitrogen in agricultural soils. Agron. Series 22. ASA, CSSA, and SSSA, Madison, WI.

U.S. Department of Agriculture, Natural Resources Conservation Service. 2010. Agronomy Technical Note, (TN) 190-AGR-3, Precision Nutrient Management Planning. Washington, DC.

U.S. Department of Agriculture, Natural Resources Conservation Service. 2011. Title 190, General Manual, (GM), Part 402, Nutrient Management. Washington, DC.

U.S. Department of Agriculture, Natural Resources Conservation Service. 2011, Title 190, National Instruction (NI), Part 302, Nutrient Management Policy Implementation. Washington, DC.

**TABLE 1 – NON-APPLICATION BUFFER WIDTH <sup>1/</sup>**

Object, Site	Situation	Buffer Width (ft.) from Object, Site
Well	Located up-slope of application site	150
Well	Located down-slope of application site provided conditions warrant application	300
Waterbody <sup>2/</sup>	Predominate slope <5% with good vegetation <sup>3/</sup>	35
Waterbody <sup>2/</sup>		50

Object, Site	Situation	Buffer Width (ft.) from Object, Site
	Predominate slope 5-8% with good vegetation <sup>3/</sup>	
Waterbody <sup>2/</sup>	Poor vegetative cover or Predominate slope >8% <sup>3/</sup>	100
Waterbody <sup>4/</sup>	Natural Riparian Buffer between waterbody and the land application area <sup>4/</sup>	60
Public Road	Irrigated wastewater or solids applied with spreader truck	50
Dwelling	Other than Producer	300
Public Use Area	All	300
Property Line	Located down-slope of application site	30
<p><sup>1/</sup> Research has shown that forested or forest/grass buffers are more effective at removing nutrients and sediment than a grass buffer. Grass buffers are more effective at removing nitrogen. Every effort should be made to reduce phosphorus movement inputs at their sources.</p> <p><sup>2/</sup> Waterbody include pond, lake, stream, wetland, or sinkhole. "Open" sinkholes should be protected the same as a well. Where sinkholes are not "open", a buffer width should be established that provides optimum filtering above the depression. Stream includes both perennial and intermittent streams.</p> <p><sup>3/</sup> Good vegetation refers to a well-managed, dense stand that is not overgrazed.</p> <p><sup>4/</sup> According to TDEC Rules for Animal Feeding Operations Chapter 1200-04-05-.14, for new CAFOs that are located adjacent to exceptional Tennessee waters and outstanding natural resource waters (as identified by the Department), leave in place a minimum 60-foot natural riparian buffer between the stream and the land application area.</p>		